Advanced Digital Waveform (ADW)

Copernicus Requirements Working Group

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Other requests shall be referred to SPAWAR PMW179.

Purpose

- **To inform the user about the quantum leaps that are currently being made in the UHF SATCOM arena**
  - UHF Standards Status
  - Advanced Digital Waveform
    - 56kbs over a 25khz channel
    - 9.6kbs over a 5khz channel
  - UHF SATCOM IP Capability
  - Integrated Waveform
    - Bandwidth on demand

UHF SATCOM Interoperability

- **Joint Chiefs of Staff CJCSI 6251.01 of 31 Jul 96**
  - Supercedes JCS Memo MCM-89-94 of 28 Jul 94
  - Currently under review and possible new revision
- **Users of Non-Processed 5-kHz and 25-kHz MILSATCOM channels are required to have terminals that are interoperable in accordance with the current versions of:**
  - MIL-STD-188-181
  - MIL-STD-188-182
  - MIL-STD-188-183
- **Users unable to comply with MIL-STD-188 must submit a Waiver to JCS (J6S)**
  - Temporary Waiver: Submitted with Satellite Access Request (SAR)
  - Technical Waiver: Entered in ICDB; Good for 2 Years
- **The overall goal is to move as many users to DAMA as possible**
  - This will free up existing UHF assets to meet other requirements

UHF SATCOM Interoperability Standards

- **Standardization effort led by DISA Joint Interoperability and Engineering Organization (JIEO) Center for Standards**

- **MIL-STD-188-181**
  - Interoperability Standard for Single-Access 5-kHz and 25-kHz UHF Satellite Communications Channels
- **MIL-STD-188-182**
  - Interoperability Standard for 5-kHz UHF DAMA Terminal Waveform
- **MIL-STD-188-183**
  - Interoperability Standard for 25-kHz UHF TDMA/DAMA Terminal Waveform
- **MIL-STD-188-184**
  - Interoperability and Performance Standard for the Data Control Waveform
- **MIL-STD-188-185**
  - Interoperability Interface Standard for 5-kHz and 25-kHz UHF SATCOM DAMA Control System (no longer being updated)

MIL-STD-188 Revisions

- **MIL-STD-188-181**
  - published: 18 September 1992
  - rev A published: 31 March 1997
  - rev B published: 20 March 1999
- **MIL-STD-188-182**
  - published: 18 September 1992
  - rev A published: 31 March 1997
  - rev B anticipated: *late 2000**
- **MIL-STD-188-183**
  - published: 18 September 1992
  - rev A published: 20 March 1998
  - rev B anticipated: *early 2000*

*** required changes for 188-182B still being considered**

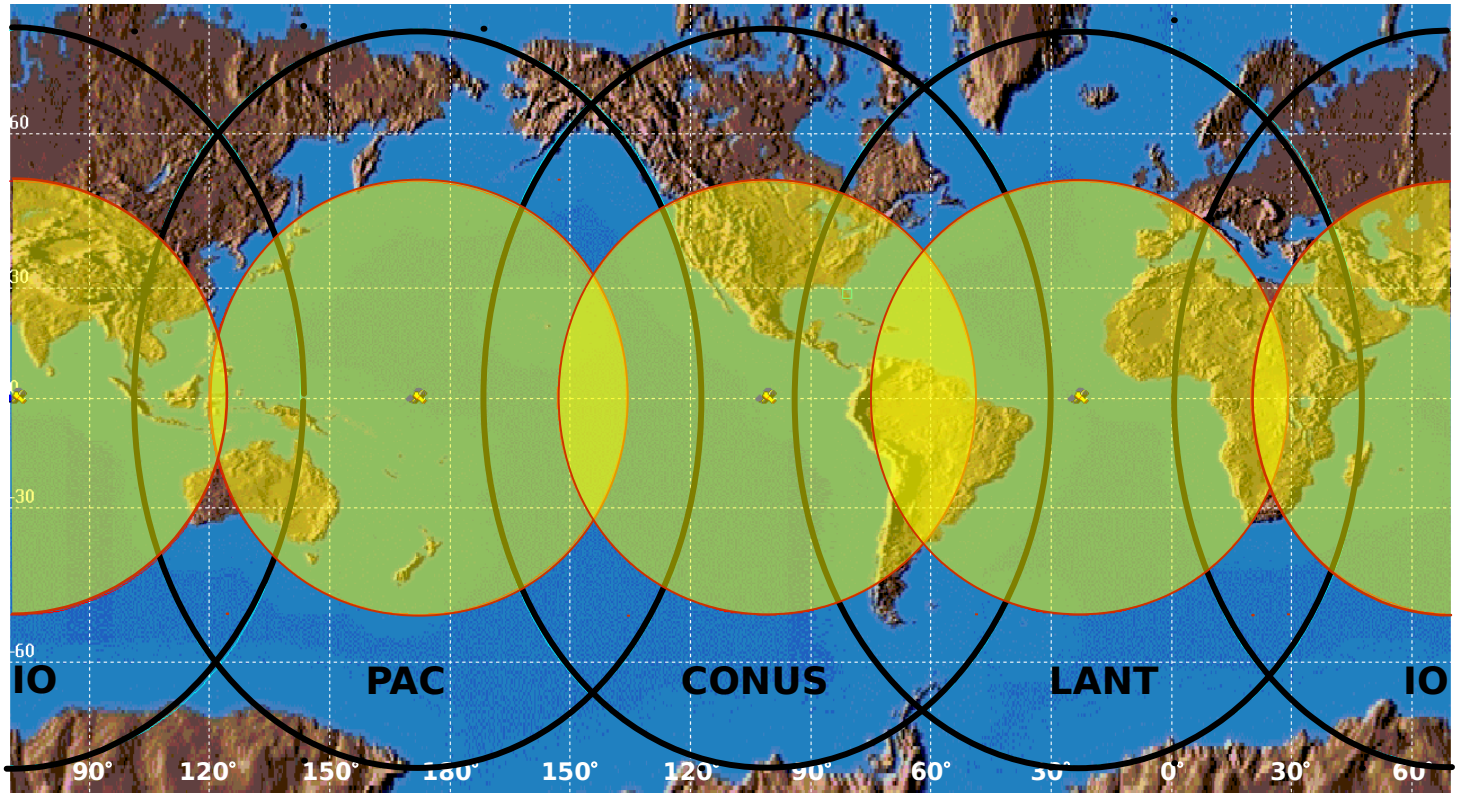
MIL-STD-188 Series Comparison

Mil-Std-188	Rev -	Rev A	Rev B
181	5 & 25 kHz Ded. Chan.	Flywheel and FEC	CPM for ~2X increase in throughput (ADW)
182	5 kHz DAMA	Reduced voice latency using subframing	Not Complete
183	25 kHz DAMA	5-kHz DAMA capability via slave channel	Not Complete
184	Adaptive Messaging Protocol for UHF SATCOM	Not Complete	-

ADW Background

- **MIL-STD-188-181B with MHCPM was published 20 March 1999**
  - 25 kHz maximum rate: 56 kbps
  - 5 kHz maximum rate: 9600 bps
- **Digital Modular Radio (DMR) will have ADW in Q4 FY00**
  - 8 ports/channel
- **MD-1324A modems have ADW capability**
  - 2 ports/channel
  - Needs external transmitter and amplifier with modem
  - Limited number of units fielded in the fleet
  - Limited number of channels per platform
    - Adding additional MD-1324s will not solve the UHF radio shortfall problem
- **Mini DAMA ADW Modification in FY00**
  - Capability fielded in FY01

Maximum Predicted MHCPM Performance (No Fade Margin)



Legacy
Ship (or Shore)-to-Ship
- 16.0 kbps over 25-kHz
- 2.4 kbps over 5-kHz

Shore-to-Sub
- 9.6 kbps over 25-kHz
- 2.4 kbps over 5-kHz

ADW Multi-h CPM
Ship (or Shore)-to-Ship
- 48.0 kbps over 25-kHz
- 9.6 kbps over 5-kHz

Shore-to-Sub
- 32 kbps over 25-kHz
- 4.8 kbps over 5-kHz

ADW Multi-h CPM
Shore-to-Ship
- 56.0 kbps over 25-kHz (95% of the time)

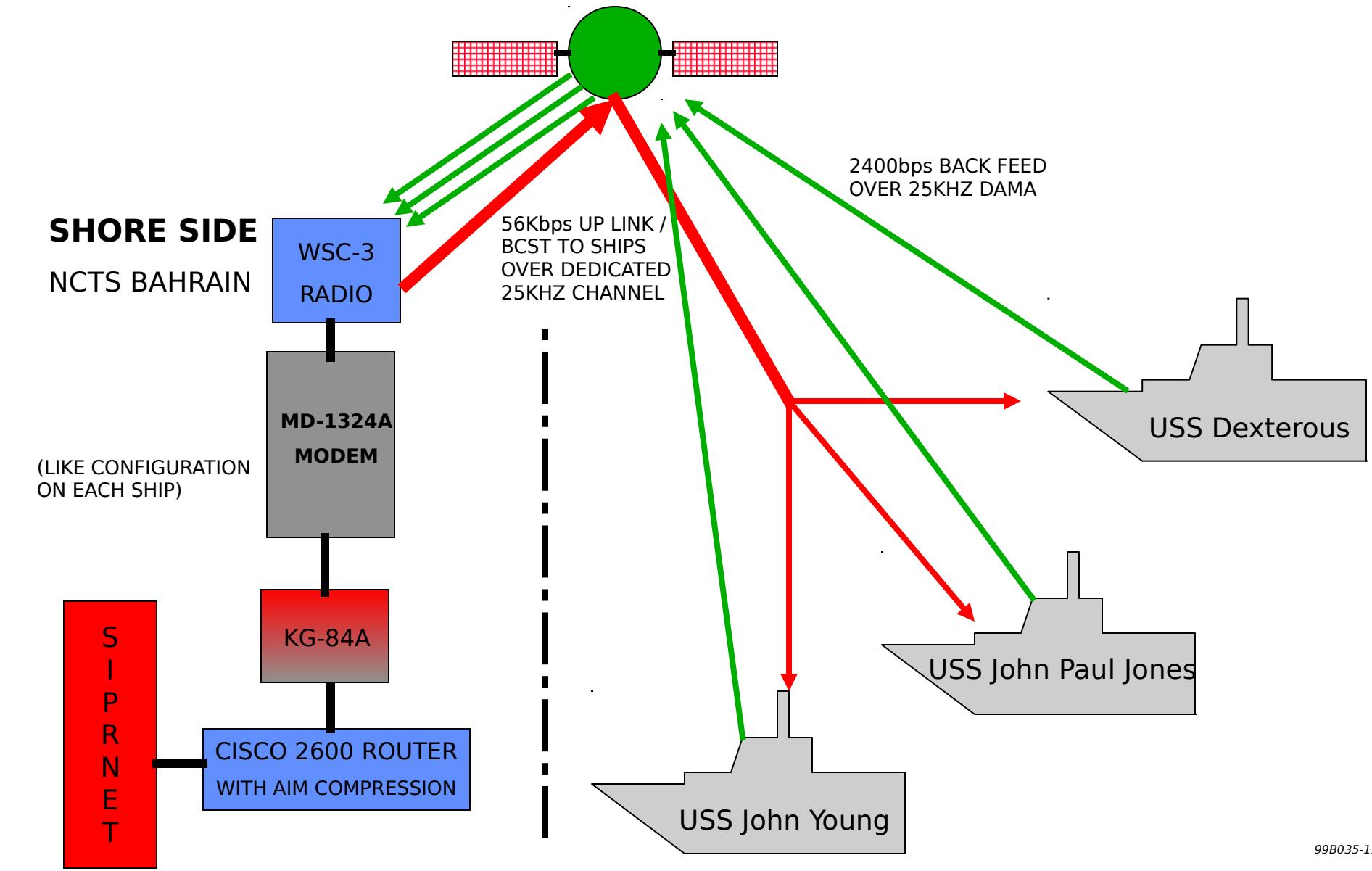
Ship to-Sub
- 32.0 kbps over 25-kHz
- 7.2 kbps over 5-kHz

ADW Is a force multiplier on UHF by more than a factor of 3!

DEMO of UHF SATCOM IP Network

- **Ongoing/Proposed Demonstrations**
  - At Sea Demonstration on USS PELELIU ARG (Ongoing)
  - SSC SD lab Evaluation of Networked IP over UHF SATCOM (Ongoing)
    - PMW158 and 179 team effort
    - Using Multiple SATCOM links in Networked Configuration
    - Using ADNS and COTS products
  - Fleet Battle Experiment –F
    - IP data transfer via asymmetric Comms
  - SSBN ADW IP Demo Dec 99

FBE-F - Demo of SIPRNET via Asymetric comms



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UHF SATCOM IP Capability Summary

- **Projected UHF SATCOM ADW IP data capability will provide fleet users a desirable SIPRNET/NIPRNET capability**
- **Current testing verifies the utility of this capability**
- **Advanced UHF SATCOM IP Capability can be fielded concurrently with DMR**
- **Even ships with INMARSAT B HSD want the ability to do UHF SATCOM IP**
  - John Paul Jones is receiving this modification as part of the Demo (FBE-F)
- **DAMAtization of UHF will help gain the user more UHF resources to meet new requirements**
  - Currently transitioning 25khz requirements to 5khz channels (OTCIXS)

Future UHF SATCOM enhancements

- **Replace two non-interoperable DAMA waveforms with a single "Integrated Waveform" (IW)**
  - Improve Performance
  - Allow full interoperability among terminals operating on 5-kHz and 25-kHz channels
  - Reduced training, only one DAMA waveform to learn
  - Simplified terminal operation
  - Reduced terminal development cost

IW Performance

- **Significantly Improves Performance**
  - Uses new Advanced Digital Waveform developed for MIL-STD-188-181B
  - More than doubles the number of voice circuits carried on each channel
    - For equivalent link margin requirements:
      - Five 2400bps time slots in near term 25-kHz DAMA (MIL-STD-188-183A)
      - Eleven 2400bps time slots in new Integrated DAMA
    - For advantaged platforms
      - Fifteen 2400bps time slots in new Integrated DAMA
    - Provides higher maximum data rates
  - Unrestricted time slot combinations
    - Communication services can be tailored to the data-rate requirement
  - Reduced voice and data throughput delays
  - Faster connection to networks
  - Directly supports use by "disadvantaged" terminals (Tomahawk, Unmanned Air Vehicles)
  - Allows for transparent operation across multiple satellites
  - Improved terminal ranging protocols

IW Operation

- **Simplified operation**
  - Allows a terminal to automatically locate and join networks
  - Provides a voice and data service modeled after the plain old telephone service
  - Provides a world wide messaging service using Internet mail protocols
  - Possible elimination of the requirement to carry orderwire keying material (subject to NSA approval)

IW Capability

- **Improved expandability and flexibility**
  - Backward interoperable with all legacy terminals
    - via 188-181 and 188-183 waveforms
  - Layered protocol simplifies use by other systems including IP systems
  - Will accommodate many systems that have not been able to use current waveforms
  - Ready for the next satellite constellation
- **188-182 warfighter requirements still supported**
  - JMINI Control System will continue to support channel control and management
  - Unified CINC, as always, determines best mix of DAMA/DASA
- **Current schedule is for this standard to be published in 4th QTR FY00**

Conclusion

- **Recent UHF SATCOM developments are impacting the fleets communications capability**
  - New standards will assist the transition to DAMA
    - Free up resources for more
  - ADW is a force multiplier of UHF SATCOM capability
- **UHF SATCOM IP capability is being tested Now**
  - Can provide another IP data capability to users
- **Future UHF SATCOM enhancements will migrate the capability to an integrated capability**
  - Seamless
  - Improved performance

- **Backup**

MIL-STD-188-182A
"that 5-kHz DAMA voice issue"

- **Problem with current standards is the long delay on**
- **5-kHz DAMA**
- **Problem: 5-kHz DAMA was designed for Data, not Voice**
  - Long link set-up delay: 18 to 27 seconds
  - Unacceptable push-to-talk delay: ~ 9 seconds
- **Solution #1: MIL-STD-188-182A**
  - Still extremely long link set-up delay
  - Does allow data to began transmitting before a full frame is buffered (sub-framing)
    - decreases push-to-talk delay to as low as 2.5 seconds

MIL-STD-188-183A

- **Solution #2: MIL-STD-188-183A**
- **Provides a new 5-kHz DAMA**
  - Totally unrelated to MS-188-182A waveform
  - Capitalizes on a terminal's frequency switching capability for DAMA access on 5-kHz channels
- **Improves upon performance offered by MIL-STD-188-182A**
  - Circuit setup delay
    - From-182A: 27 secs TO-183A: 4 secs
  - Throughput delay
    - From-182A: 2.5 secs To-183A: 0.8 secs
  - Supports two simultaneous 2400 bps services or a 4800 bps service on a 5-kHz channel

IW and ADW UHF Improvement
One Satellite Only

	CONUS											
	Today						With ADW and IW					
	25-kHz			5-kHz			25-kHz			5-kHz		
	Channels	DAMA	Networks	Channels	DAMA	Networks	Channels	DAMA	Networks	Channels	DAMA	Networks
JFCOM	14	3	36	16	0	16	13	12	132	16	16	48
SOUTHCOM	14	0	14	8	0	8	5	5	55	8	8	24
PACOM	1	0	1	3	0	3	1	1	11	3	3	9
SOCOM	0	0	0	1	0	1	0	0	0	1	1	3
TRANSCOM	1	0	1	1	0	1	0	0	0	1	1	3
SPACECOM	1	0	1	0	0	0	1	1	11	0	0	0
JCS	7	0	7	10	0	10	5	5	55	10	10	30
WHCA	4	0	4	0	0	0	2	2	22	0	0	0
OPEN	0	0	0	0	0	0	8	8	88	7	7	21
TOTAL	42	3	**64**	39	0	**39**	35	34	**374**	46	46	**138**

Total 5-kHz & 25-kHz Nets Today = 103

Total 5-kHz & 25-kHz Nets with ADW & IW = 512

Notes:
(1): for "today", the 25-kHz channel count includes both 25-kHz individual transponder channels and the 25-kHz channels off the 500-kHz wideband channel
(2): for "with ADW/IW", the 25-kHz channel count is reduced by the number of 25-kHz channels off the 500-kHz wideband, since these channels do not operate DAMA. The net effect is 13 less 25-khz channels but 7 more 5-khz channels
(3): for "today", number of networks/channel is 1/1 except for DAMA where it is 5/1
(4): for "with ADW/IW", the number of networks/channel is 11/1 for 25-kHz and 3/1 for 5-kHz.